Sediment Quality at the Point Grey Disposal Site, 1975-2001

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The Point Grey marine disposal site is located off Vancouver, at a depth of 230-250 m in the Strait of Georgia. The site is defined as a circle, radius one nautical mile, centred on 49°50.40' N and 123°22.10' W. It is the most intensively used marine disposal site on Canada's West Coast, receiving about 400,000 m^3 of waste annually over the period 1975-2001. The material sent to Point Grey is predominantly derived from dredging in the Vancouver area, and waste classified as inert, inorganic material of geological origin. Work in the 1980's suggested that the seabed around the site is totally depositional, meaning that material that reaches the seabed within the site boundary should remain there.

We reviewed 26 years of environmental monitoring data obtained by Environment Canada. Monitoring began in 1975, when Environment Canada took over the responsibility for what is now called disposal at sea but was then called ocean dumping. Our review ended with data from 2001, including the data from 23 sampling surveys over the 26-year period. Throughout this time the sampling plan consistently formed a series of concentric rings about the centre of the site, with radii of 0.0, 0.5, 1.0, 1.5, 2.0 and 3.0 nautical miles (Figure 1). Our analysis of the data focused on these concentric rings, with the site centre and the two smallest rings forming the group of Inside stations (inside the site boundary), and the three outer rings forming the Outside stations. A reference site was located 6 nautical miles south of the centre, well within the influence of the plume from the main arm of the Fraser River.

The sediment quality data site could typically not be normalized by common transformations, despite sample sizes greater than 650 for some of the tests. The results reported here are all based on non-parametric statistics.

We reviewed both spatial and temporal patterns in sediment chemistry. Metals focused on were Cu, Pb, Zn, Hg, and Cd. The first four of these increased in concentration from the centre towards the 3-mile ring, while Cd showed the opposite pattern. The particle size spectrum is complementary, coarsest at the centre of the site and increasing with distance outwards. Cluster analysis of the metal and particle size data together separates the Inside from the Outside stations. Remembering that the site is non-dispersive, it appears that the material disposed has been coarser than the rest of the sediment in this area, and has contained lower concentrations of four heavy metals.

The spatial pattern of PAHs is opposite to that of most of the metals. PAH concentrations in the sediment were highest at the centre of the site and decreased with distance outwards, dominated by the high molecular weight group. Cluster analysis of station-PAH data separates the Inside stations but also suggests a possible spread of PAHs to the north and northeast, in the direction of the residual current.

The temporal pattern of PAHs and metals differs. Inside the disposal site boundary all of the metal concentrations decreased over time while the particle size spectrum coarsened. Only Hg and Cd showed a similar decrease with time at stations outside the disposal site boundary, where there was no temporal trend in particle size.

PAHs again show the opposite pattern. Both the high and low molecular weight fractions increased over time at Inside and Outside stations. The rates of increase were similar over the whole area, suggesting that PAH concentrations have been influenced by a larger, more regional scale phenomenon than disposal at sea.

Average Cd and Pb concentrations at the 42 stations in the monitoring program were always less than the CCME's ISQG, while Cu and Hg averages were sometimes less than the ISQG but usually lay between the ISQG and the PEL. No station-averaged metal concentrations were above the PEL.

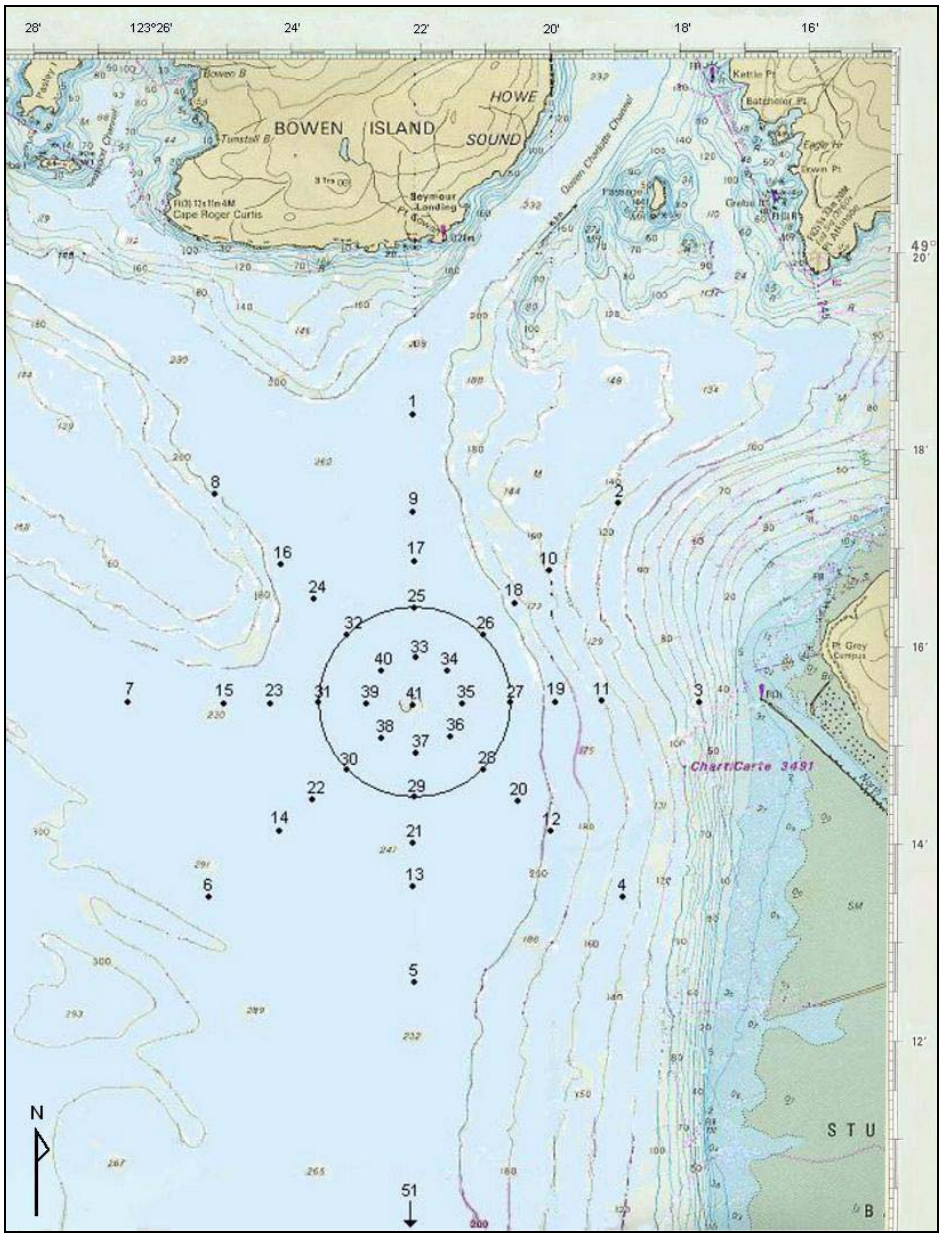

Figure 1: This sampling pattern of concentric rings was used throughout the period 1975-2001. Not all stations were sampled in each of the 23 surveys whose data we compiled.

Station-averaged PAH concentrations also lay between the ISQG and PEL at some stations but were never above the PEL. The probability of a toxic effect due to an individual PAH is less than 14%. Risk modelling (Field *et al.*, 2002) of the highest PAH concentrations at the centre of the disposal site show the probability of a toxic effect due to the PAH mixture is 26%.

Coincidentally, 28% of 25 sediment samples from Inside stations showed toxicity when tested with the amphipod *Eohaustorius washingtonianus*. Testing with *Rhepoxinius abronius* showed no toxicity, suggesting that this species is less sensitive. Bioassays of the white sea urchin *Lytechinus pictus*, using the fertilization endpoint, found toxicity 27% of the time at the Inside stations and no toxicity Outside. The Microtox® test showed toxicity at Inside stations 35% of the time.

Overall, it appears that sediment contaminants caused toxicity inside the disposal site boundary 27-35% of the time, but only rarely caused toxicity outside the site boundary. The most likely causes of the toxicity observed are the PAH concentrations, which have been increasing over time throughout the area sampled but are highest inside the disposal site boundary.

Literature Cited

Field, L.J., D.D, MacDonald, S.B. Norton, C.G. Ingersoll, C.G. Severn, D. Smorong, & R. Lindskoog, 2002, Predicting amphipod toxicity from sediment chemistry using logistic regression models, *Env. Toxicol. Chem.* **21(9)**:1993-2005.